

Extratropical cyclones and fronts database

Created by Catherine M. Naud, 2017.

Feedback welcome: cn2140@columbia.edu, or contact James Booth: jbooth@ccny.cuny.edu

See end of document for relevant citations and other resources.

Each file contains (200-250 kb per file, 1 month ~ 720 Mb):

- MERRA-2 gridded SLP with corresponding latitude and longitude for a $\pm 40^\circ$ region around the cyclone center
- Extratropical cyclone center location from MCMS (Version 4) database, SLP minimum (from ERA-interim*) and fraction of land cover (0-1; from MERRA-2) at the storm center
- Cold front location detected from 3 methods: Hewson 1km, Simmonds et al. 850 hPa and a combination of the two methods
- Warm front location: Hewson at 1km, Hewson at 850 hPa, Hewson at 850 hPa using wet bulb temperature

***Note of explanation:** the cyclones were detected and tracked using ERA-interim SLP that was downloaded from ECMWF at 1.5° horizontal resolution (even though it is available at 0.75° resolution). This is because the MCMS Version 4 code was optimized for gridded data at a resolution between 1° and 2° . Then, the gridded SLP and the fronts are detected using MERRA-2, in part because MERRA-2 was available at the highest spatial resolution at the time of this processing (2016).

Filename convention:

MERRA2fronts_YYYYMMDD_UT_Latstorm_Lonstorm_surfacetype_IDofTrack

YYYYMMDD: year month day

UT: time in hours, UT

Latstorm: latitude of the low pressure center

Lonstorm: longitude of the low pressure center

Surfacetype: land or ocean, ocean if less than 50% land cover in MERRA-2

IDofTrack: Each file contains information for ONE cyclone center. Each center belongs to a track. To find the collection of files that follow the same storm along its track, this fairly long suite of number is unique to that track, so all files that finish with this number refer to 6-hourly occurrences of the same storm.

Front locations best estimates: (highlighted in contents list below)

- Cold front = **CF_combined**
(a joint detection using both Hewson (temperature gradient method) at 1 km above surface and Simmonds et al (using wind change method) at 850 hPa).
- Warm front = **WF_Hewson1km** (Hewson's method at 1 km above surface)

Remark: If the best-estimates are 1) not satisfactory and/or 2) not available, try the other two possible products for each front. Sometimes Hewson 1 km gives a cold front location but the combination with Simmonds has failed, and the wet bulb warm front gives much better results than the dry temperature at 1 km product in occluded type situations over oceans.

Warning: This is an experimental product with flaws, some still unclear, others already identified.

Already known:

- 1) the front detection works as long as there is no occlusion. When that happens, it will often be the case that the algorithm cannot detect either front, or it confuses cold and warm front, or it links the two together;
- 2) Also, in situations when 2 cyclones are very close to one another, for example when a secondary low starts to form along the cold front of a primary cyclone, the part of the algorithm that pairs fronts and cyclone centers can get confused. So you might have a warm front paired with a given cyclone that is in fact associated to another cyclone.

Contents:

0:longitude	(2D longitude field from MERRA-2 covering $\pm 40^\circ$ around ETC center)
1:latitude	(2D latitude field from MERRA-2 covering $\pm 40^\circ$ around ETC center)
2:MERRA2SLP	(2D SLP field from MERRA-2 covering $\pm 40^\circ$ around ETC center)
3:storm_info	(4 parameters: longitude, latitude, SLP and land fraction at the center)
4:CF_hewson1km	(2xn_elements: 0=longitude and 1=latitude of <i>cold front</i> detected with Hewson method for (dry) MERRA-2 potential temperature at 1 km above surface. Works best in high baroclinicity environment, e.g. in winter, and should provide fronts similarly over land and ocean)
5:CF_simmonds850	(2xn_elements: 0=longitude and 1=latitude of <i>cold front</i> detected with the Simmonds et al. method using winds at 850 hPa. Might have troubles over land but works well in low baroclinicity environments).
6:CF_combined	(2xn_elements: 0=longitude and 1=latitude of <i>cold front</i> detected with a combination of both methods described above, i.e. 1 km Hewson and 850 hPa Simmonds. This is the cold front location best estimate. Note that sometimes the algorithm does not provide a “merged” product when Hewson or Simmonds might find one. So if there is no merged product, check Hewson 1 km first then Simmonds detections)
7:WF_Hewson850	(2xn_elements: 0=longitude and 1=latitude of <i>warm front</i> detected with the Hewson method for potential temperature at 850 hPa. Might not work very well over land.)
8:WF_Hewson1km	(2xn_elements: 0=longitude and 1=latitude of <i>warm front</i> detected with Hewson method for potential temperature at 1 km above

9:WF_HewsonWB

surface. Works over land. This is the best estimate for warm fronts.)
(2xn_elements: 0=longitude and 1=latitude of *warm front* detected with Hewson method using wet bulb potential temperature at 850 hPa. Works better than above in occluded situations. Best to check this location if 1 km Hewson missing or incomplete.)

References and recommended reading:

This database:

Naud, C.M., A. D. Del Genio, M. Bauer, and W. Kovari, 2010: Cloud vertical distribution across warm and cold fronts in CloudSat-CALIPSO data and a general circulation model. *J. Climate*, **23**, 3397-3415.

More specifically for cold fronts:

Naud, C.M., J.F. Booth, and A.D. Del Genio, 2016: [The relationship between boundary layer stability and cloud cover in the post-cold frontal region](#). *J. Clim.*, **29**, no. 22, 8129-8149, doi:10.1175/JCLI-D-15-0700.1.

- MCMS database for cyclone location and tracking (based on ERA-interim SLPs):

<http://gcss-dime.giss.nasa.gov/mcms/>

Bauer M. and A. Del Genio, 2006: Composite analysis of winter cyclones in a GCM : influence on climatological humidity. *J. Climate*, **19**, 1652-1672.

Bauer M., G. Tselioudis and W. B. Rossow, 2016: A new climatology for investigating storm influences in and on the extratropics. *J. Appl. Meteorol. Climatol.*, **55**, 1287-1303.

- Front detection methods:

Hewson, T. D., 1998: Objective fronts. *Meteor. Appl.*, **5**, 37–65.

Simmonds I., K. Keay and J. A. T. Bye, 2012: Identification and Climatology of southern hemisphere mobile fronts in a modern reanalysis. *J. Climate*, **25**, 1945-1962.